Climate Information System for Agriculture and Water Resource Management in the Southeast USA

Progress Report of SECC to NOAA RISA Program
January – December 2007

Introduction

The Southeastern Climate Consortium (SECC) conducts research to help decision-makers manage climate related risks to agriculture and natural resource management in Alabama, Georgia, and Florida. The SECC cooperates with the Extension Services of the three states and other agencies and organizations to provide climate information to stakeholders in agriculture, forestry, and water resource management. This Progress Report for January – December 2007 is being submitted by the University of Miami, which manages the cooperative agreement with NOAA for the SECC members (University of Miami, University of Florida, Florida State University, and University of Georgia, and University of Alabama-Huntsville). Auburn University is also a member of the SECC.

Our overall goal is to develop a climate information and decision support system for the Southeastern USA that will contribute to an improved quality of life, increased profitability, decreased economic risks, and more ecologically sustainable management of agriculture, forestry and water resources.

Toward this goal we have established the following objectives:

1. To develop downscaled ENSO climate information and forecasts for the Southeastern USA.
2. To enhance and extend agricultural applications of climate forecasts in the Southeastern USA.
3. To develop and refine methods to incorporate climate forecast in water resource management in the Southeastern USA.
4. To develop new and improved methods for integrating models from different disciplines for application of climate forecast information in agricultural and water resource decision making.
5. To foster effective use of climate information and predictions in forestry and wildfire management.
6. To document and assess the utility and impact of climate forecast information provided to stakeholders in agriculture and water resource management.

As a multi-institutional consortium, different member institutions of the SECC emphasize project objectives that build on the strengths of each institution. The University of Miami investigators focus on Objectives 2, 4, and 6. University of Florida, on Objectives 2, 3, and 4. Florida State University, on Objectives 1, 3, and 5. University of Georgia, on Objectives 2 and 3; and University of Alabama-Huntsville, on Objective 2.

A major part of our research and extension effort in 2007 was directed toward the transition of *AgClimate* to the Florida Extension Services with additional funding from the NCTP (TRACS) program. This effort is being conducted in close cooperation with the Florida Agricultural Weather Network, which will share servers with *AgClimate*.

In response to stakeholder requests and questions, in 2007 we began efforts to develop information on climate change. We have begun this effort through the development of a series of fact sheets that will be released both through *AgClimate* and through printed documents.

CIMAS Research Theme: Theme 4: Human Interactions with the Environment

Link to NOAA Strategic Plan Goals: NOAA Mission Goal 2: Understand Climate Variability and Change to Enhance Society's Ability to Plan and Respond. NOAA Mission Goal 3: Serve Society's Needs for Weather and Water Information. Strategy: To develop generic tools for the production and dissemination of relevant climate information (diagnostic and forecasts); to strengthen decision making in agriculture.

Following are progress reports from each of the SECC member institutions that receive NOAA funds along with listings of SECC publications and outreach activities.

University of Alabama – Huntsville

Development of Improved Lawn and Garden Index

Drought indices are an important tool in conveying information to the public and government/industrial decision makers. However, at the outset the definition of a drought is subjective and depends on the user, time scale and time of year. A hydrological drought for a large basin is quite different in the time and spatial scale than for a drought impacting lawns and agricultural crops or even droughts affecting deep rooted forests. The lawn and agricultural drought can develop on a relatively short time scale and be highly local depending on small scale summer convective events. For this reason UAH developed a Lawn and Garden Index (LGI) that considers the relatively fast loss of moisture in the upper part of the soil and utilizes a high resolution radar derived precipitation data set to resolve the small spatial scale variations in rainfall.

The Lawn and Garden Index proved popular with the public and water resources managers in Alabama and thus was expanded to the Southeast under the Southeast Climate Consortium. It is now delivered as part of the Ag Climate Information System.

Improvements

A lawn and garden or agricultural drought involves two key variables. First is the amount of precipitation input to the soil and the second is the loss of moisture from the soil. At the present time the LGI uses probably the best available product for specifying the amount and spatial distribution of precipitation. This is a NOAA Climate Prediction Center radar derived but gauge adjusted rainfall data set at a resolution of four kilometers over the Southeast.

While the precipitation input is a highly quantified variable, the loss of moisture in the soil in the current LGI is highly idealized and parameterized. It attempts to replicate evapotranspiration losses by soils and plants and run-off losses and infiltration by making the available moisture index a temporal declining function. While physically intuitive the function itself is relatively ad hoc.

Under this activity UAH in cooperation with the University of Georgia will continue the planning and testing of a process to improve the loss component in the lawn and garden index. This will involve two activities given below.

In this past reporting period we have updated the static evapotranspiration curve to be slightly more realistic in the LGI. The LGI was used extensively during the drought of 2007 in determining drought designations for the SE in the U.S. Drought Monitor (P.I. Christy is the main information source for Alabama's Drought Monitor designations, for example)

Inclusion of observed insolation

Incoming solar radiation is a key component in the amount of evapotraspiration. In fact many estimates of potential water use by vegetation are solely dependent on insolation. Unfortunately, surface observations of solar radiation are limited. Insolation is also highly spatially variable due to clouds so that sparse observations are of little use in interpolation attempts. Satellites, however, measure reflected radiation very well and can thus theoretically infer surface insolation. Thus, NOAA NESDIS has fostered the development of methods to derive insolation from NOAA operational geostationary satellites that can provide excellent temporal and spatial estimates. These include both statistical (Tarpley et al.) and physical retrievals (Gautier and Diak) of insolation.

In this activity UAH will begin the testing of the use of an insolation product derived from NOAA GOES to include in the LGI to better capture the spatial evaporative loss part of the LGI. UAH in conjunction with NASA currently produces an hourly 4 km insolation product over the Southeast from NOAA GOES. This will provide a loss component estimate on a scale consistent with the radar derived input. The initial employment of the insolation product will be used to calculate/scale potential evaporation rates.

In the past year we have successfully coded the scripts to access the GOES data for ingestion into DSSAT (see below). We now have 7 months of data. However, the output data from GOES access points have recently changed formats and we are dealing with adjustments now.

Incorporation of Crop Models

While the insolation input should improve the average estimate of evapotranspiration loss in the LGI, there are other factors such as soil types and depths, specific types of vegetation and crops and slope that alter water loss. Crop models such as DSSAT employed by the SECC have the potential to specifically calculate both water loss and more directly plant water stress. Under this activity UAH will work with the University of Georgia (UGA) to plan on how the crop models can be employed within the LGI to provide specific information on grass/crop stress and soil moisture availability. Under other funded activities UAH is working with UGA to have soil profiles built for the three dominant soil classes in each county in the SECC domain. The soil data in the crop models coupled with the observed in situ weather data and weather interpolators developed under the SECC along with the radar derived rainfall and insolation data have the potential for producing a new type of agricultural drought index which is physically based and would have excellent spatial coverage.

Initial DSSAT runs have been successful in discriminating crop health relative to irrigated and non-irrigated grid squares, and thus the crop-moisture condition of the soil (which is the variable we are quantifying). Tests have been completed on variable solar radiation input and the impacts on evapotranspiration which directly affects crop-moisture availability. Thus the model is near ready for the real-time implementation of the solar radiation ingestion.

Florida State University

Background

The natural variability of climate in the United States can disrupt activities such as agriculture, forestry, and the allocation of water resources. While "weather" may only be predicted a few days in advance, new understanding of "climate" variability, especially as caused by El Niño and La Niña, permits probabilistic forecasts of more or less than normal rainfall and shifts in average temperatures. Climate variability is also known to affect the frequency of extreme events such as hurricanes, tornadoes, wildfires, and damaging freezes.

The Southeast Climate Consortium (SECC) has its origin in the Florida Climate Consortium (FLC), which was formed in 1996 by three Florida universities (Florida State University, University of Florida, and University of Miami). Initial research of the FLC focused on the agricultural sector in Argentina, but in 1998 focus shifted to Florida. Early FLC work was supported by NOAA-OGP as a pilot Climate Applications Project. When the Regional Integrated Sciences and Assessment (RISA) program was established, the FLC work was transferred to the purview of this program. In 2002, the FLC expanded to become the SECC, initiating interactions and joint activities among consortium member institutions in Florida and Georgia and expanding the focus to the southeastern United States. USDA-RMA funding awarded in 2003 allowed the expansion of consortium activities to include Alabama with further integration of SECC activities. Current members of the SECC include Auburn University, Florida State University, University of Alabama at Huntsville, University of Florida, University of Georgia, and University of Miami. Over the past three years, the SECC has broadened its target stakeholders to not only include agricultural producers, but also water resource managers, forest managers, and policy makers.

The SECC brings together expertise from different physical, biological and social science disciplines. Our mission is to use advances in climate sciences, including improved capabilities to forecast seasonal climate, to provide scientifically sound information and decision support tools for agriculture, forestry, and water resources management in the Southeastern USA. An important aspect of the FSU climate program in the RISA is the ARSCO State Climate Office. An ARSCO is an American Association of State Climatologist Recognized State Climate Office (ARSCO). As an ARSCO, the state climate offices work in partnership with the National Climatic Data Center, the Regional Climate Centers, and the National Weather Service to provide climate services to their states. ARSCO status gives Florida State University and The Southeast Climate Consortium unique avenues for stakeholder interaction and credibility with government agencies and news media.

The understanding of climate and climate variability and communicating the associated risks and benefits to the end user is the key component, which interconnects all SECC activities.

Historically, the Florida State University has been the lead institution in the acquisition and analysis of historical climate data, research on climate variability in the Southeast U.S., dynamic climate modeling, and the production of climate forecast information for incorporation in decision support systems, which target the end user.

Coupled climate-crop models and downscaling

In order to build a firm bridge between the numerical climate model and the crop model, we are studying. We have investigated the performance of an advanced land model, the Community Land Model 2, in the seasonal dynamical downscaling of surface fields (maximum and minimum temperatures, precipitation, and solar radiation) through the FSU regional climate model (Shin et al. 2005) and explored the suitability of these surface fields for crop yield estimations using a state-of-the-art processed based crop model (e.g., DSSAT 4.0 family of crop models). These models are able to simulate between 2.5 and 10% of the observed yields when accurate data for crops, soils and weather are available (Mavromatis et al. 2002)

However, the dynamical downscaling approach may be compared to statistical/empirical techniques for generating weather variables for the crop models. We have also developed hybrid statistical/dynamical methods that will use statistical corrections to dynamically downscaled results to correct biases and to further extract climatic signals to enhance climate prediction for crop model application. It is not only important to forecast monthly means accurately, but daily weather characteristics as well (e.g. frequency of precipitation, diurnal temperature courses, net radiation at the surface, etc.) which are important for crop models.

Ensemble simulations are used to characterize uncertainty in the forecast. An initial condition ensemble of at least 10 members is used in the climate model. An ensemble based on using different parameterizations in the model can be used in addition to take in to account model uncertainty, as was done in the study by LaRow et al. (2005) using convective parameterizations. These ensembles are used to make probabilistic forecasts of crop yields at multiple sites. In addition, a coupled version of atmospheric and land-surface-vegetating models will be developed to capture the nonlinear seasonal weather-yield interactions (Challinor et al. 2003) with the prospect of improving both yield and climate model forecasts simultaneously. Satellite information is used in assessing the performance of the vegetation model to predict the leaf area index (LAI) and soil moisture levels. We intend to offer this technology to the Arizona RISA and the Pacific RISA when we are confident in the performance of this approach. Finally the scope of the project will be expanded with the help from the IRI to include international locations in Kenya.

Update, expand, and automate climate database operations

Historical weather data is critical to all aspects of this project and provides the basis for all climate information used in the decision support tools, including the wildfire risk forecast. In addition, the historical weather data drives the crop development models whose output is used in peanut, tomato, and potato decision aids. The historical weather data must have a long period (at least 50 years) of relatively homogeneous records and must have a spatial resolution fine enough to reveal detailed climate information at the county level for Florida, Georgia, and Alabama.

The preparation of a historical weather observation database for the Southeast is complete. The weather observations are compiled from the National Weather Service's Cooperative Observer network (NCDC TD 3200) and contain daily values of maximum temperature, minimum temperature, and precipitation for a period of record of at least 50 years extending through December of 2004. The stations are selected based on: 1) length of record, 2) data completeness, 3) homogeneity, and 4) representativeness to surrounding agricultural areas. The state climate offices in Florida, Georgia, and Alabama rely on their local expertise and familiarity with the coop network in making the station selections. The final data set contains historical weather records from 92 stations in Florida, 64 stations in Georgia, and 58 stations in Alabama.

Raw weather data were collected by the state climate offices in Florida, Georgia, and Alabama and sent to Florida State University for quality control and compilation into a common format. The data has been rewritten into portable ASCII files and also into DSSAT format that is used by the crop models. The data was also resample using a technique know as bootstrapping, creating a data set of 1,000 "synthetic" years of monthly data for each weather station and for each ENSO phase. These bootstrapped values are used to generate smooth probability density functions for the climate variables, which drive the probability graphs displayed in the climate tool on *AgClimate* (AgClimate.org). All of these formats have passed final quality checks and are now used operationally. The data base is available to all SECC members and other interested parties at a common ftp site: ftp://secc.coaps.fsu.edu.

Raw weather observations and the bootstrapped "synthetic" climate date describe the first level of the SECC data base structure, and these data are used both in operations and in research. For operational use in driving the climate decision support tool on *AgClimate*, the data have also been transferred into secondary and tertiary levels using MySQL database server. The secondary level simply mirrors the information found in the primary level, only stored as MySQL data tables and housed on the dedicated SECC server which supports *AgClimate*. The tertiary level of climate data has been condensed into information which is passed directly to the climate tool for display in *AgClimate* in response to user queries.

In order to provide the most current information possible, the historical climate data must be updated periodically. The initial data gathering was done in 2003 by manually downloading the data from servers at the National Climatic Data Center (NCDC). We are currently updating the climate data to include all of 2007 and the manual process has proven cumbersome and time consuming, especially when translating the data to the secondary and tertiary levels. The ability to automate and streamline this update process has become apparent and critical to the future of this project. An automated update process would not only provide the most current information, but allow us to refine some climate and crop-related products to include near-real time climate events and processes.

In conjunction with automating the database updates, we find it beneficial to include weather observations from our partners with the agricultural weather networks in the Southeast, specifically the Florida Automated Weather Network (FAWN) and the Georgia Automated Environmental Monitoring Network (GAEMN). The inclusion of these networks will be instrumental in the development of products that rely on near-real time observations and in filling in gaps that exist in the current NWS Coop network.

Research on ENSO variability in the southeast USA

To characterize the occurrence and the strength of ENSO phases, one can focus on either the atmospheric or the oceanic signatures, more rarely on a combination of the two. Examples of indicators based on the atmospheric component are the Southern Oscillation Indices (SOI) defined by the Australian Bureau of Meteorology or the US Climate Prediction Center. Because they are based on differences of local measurements, these indicators are relatively noisy. An example of more complex ENSO indicator is the multivariate ENSO index (MEI), introduced by Wolter and Timlin (1993, 1998).

We aim to compare the definition of ENSO phases according to two popular SST-based indicators: the Oceanic Niño Index (ONI) and the Japanese Meteorological Association (JMA) index. The ONI was designed by the US Climate Prediction Center, and is the main indicator used for their regular ENSO outlook. The JMA index (JMAI) has been used in many studies and is the indicator chosen by the Southeastern Climate Consortium for their own ENSO outlook. A comparison was made of the occurrence and strength of ENSO episodes. We then compared the impact of the two indicators on station precipitation in the southeastern USA.

Research was also done on climate impacts in the United States using a non-traditional climate data set. Oregon State University provides PRISM (Parameter-elevation Regressions on Independent Slopes Model) climate data, developed by Dr. Christopher Daly, PRISM Group director. PRISM is a unique knowledge-based system that uses point measurements of precipitation, temperature, and other climatic factors to produce continuous, digital grid estimates of monthly, yearly, and event-based climatic parameters. ENSO composites of monthly rainfall and temperature have been produced that show highly detailed patterns of climate shifts.

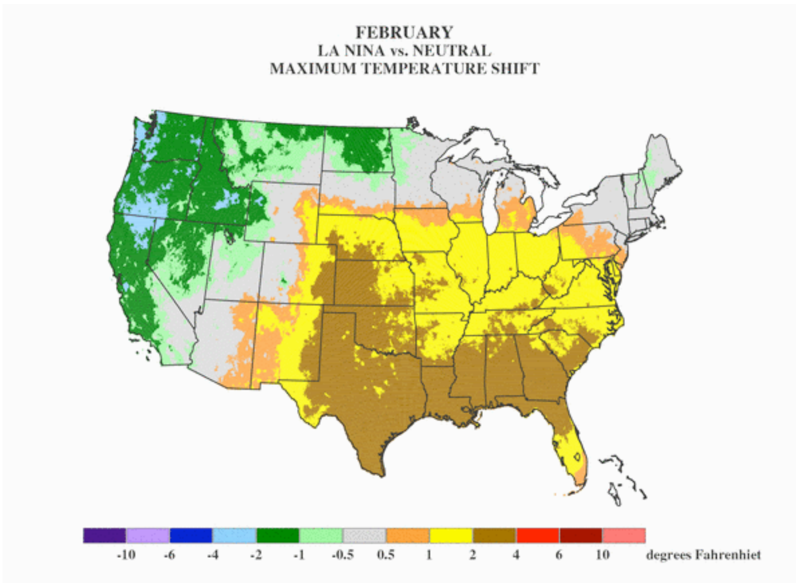


Fig. Map showing the shift in mean for average daily maximum temperature during La Niña episodes using PRISM data.

Long-term trends and climate change

The first step in preparing for a changing climate system is a thorough understanding of the past climate. A careful analysis of historical weather and ocean observations reveals useful information on the average state and variability along with changes on time scales from seasonal, to interannual (1-5 years), decadal, and even long-term trends. As described above, much is known about the year-to-year variations as caused by the El Niño/La Niña cycle in the Pacific Ocean. There are also variations on time scales from 10-50 years, such as the known warm periods around 1950 and 2000 and the cold winters of the 1980's. Warm season precipitation has dropped 10% to 15% in recent decades around central and south Florida, whether caused by land use changes or by circulation changes in the Atlantic Ocean. Many Florida weather stations also exhibit long term trends in temperature and rainfall, whether caused by a changing global climate or by local changes in land use and urbanization.

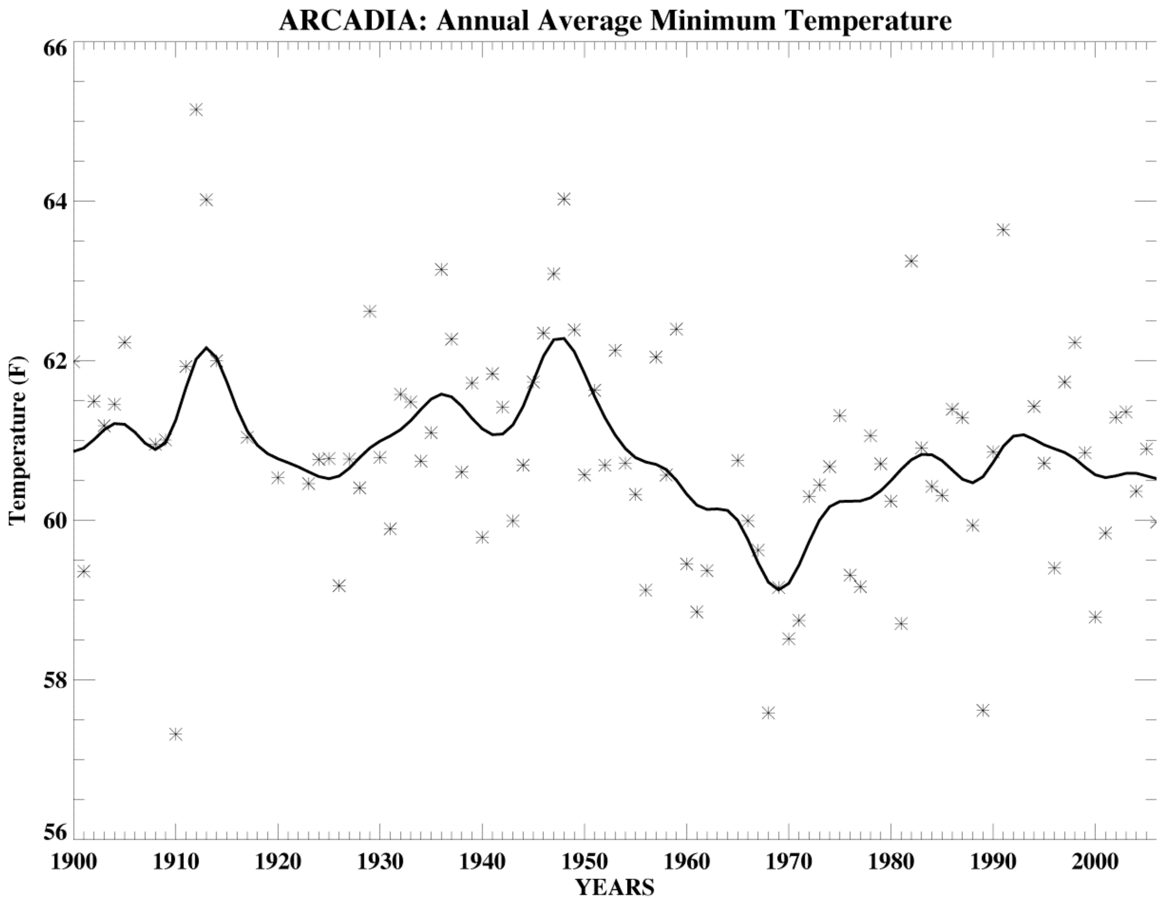


Fig. Long-term record for overnight minimum temperatures for Arcadia, FL.

In a 2007 study on temperature trends in the U.S. that will be submitted for publication, Daily maximum and minimum temperature data from 758 COOP stations in 19 states are examined. All stations used contain records from 1948 through 2004 and could not be missing more than 5 consecutive years of data. Missing data is replaced using a multiple linear regression technique from surrounding stations. For each station, the maximum and minimum temperatures are first sorted in ascending order for every two years (to remove annual variability) and divided into ten equal parts (or deciles). The first decile represents the coldest temperatures, and the last decile contains the warmest temperatures. A Hanning filter is used to further smooth the high frequency variability. From these decile plots, patterns and trends can be seen over the 56-year period.

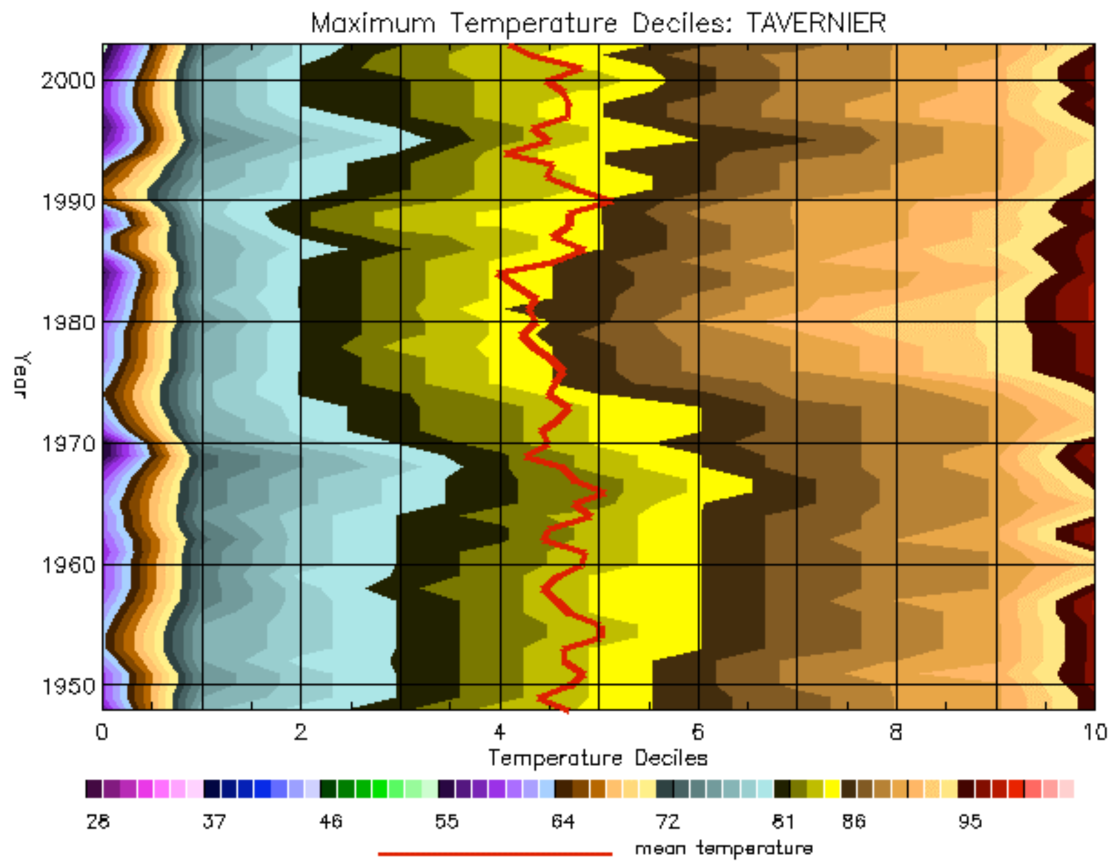


Fig. Decile plot for average daily maximum temperature in Tavernier, FL.

To determine if a station has experienced warming or cooling over the period, a linear least-squares interpolation is applied to each decile for the maximum and minimum temperatures. Significant warming or cooling was determined by student's t-test. Bootstrapping the decile data will further examine the validity of significance. Regional maps show the spatial patterns of the warming and cooling trends.

Two stations were closely examined to identify any trends. These case studies show that local effects often play a much more important role than large-scale shifts in dictating the significant temperature changes observed at a station. A regional analysis is then performed to determine the reasons for more widespread patterns. Results of this study are presented in a GIS-based web tool at COAPS: http://www.coaps.fsu.edu/gis/decile.php

COAPS is also responding to user requests for general information regarding climate change and global warming. We have contributed information to a series of "fact sheets" the SECC has developed on the subject of climate change, adaptation and mitigation strategies, and agricultural impacts.

Focus on variability of extremes and extreme events

Studies have shown that very limited benefit exists in climate forecasts focused on shifts of temperature or precipitation near the climatological average. It is possible that the greatest benefit lies in the forecast of extremes, events near the tails of the historical probability distribution. Further research is needed that addresses the likelihood of extremes, such as torrential rainfall, drought, freezes, and hurricanes.

El Nino-Southern Oscillation (ENSO), North Atlantic Oscillation (NAO), Pacific Decadal Oscillation (PDO), and Polar Vortex Oscillation (PVO) produce conditions favorable for monthly extreme temperatures and precipitation. These climate modes produce upper level teleconnection patterns that favor regional droughts, floods, heat waves, and cold spells, and these extremes impact agriculture, energy, forestry, and transportation. The above sectors prefer the knowledge of the worst (and sometimes the best) case scenarios.

Another COAPS 2007 study to be submitted for publication examines the worst and best case scenarios for each phase and the combination of phases that produce the greatest monthly extremes. Data from Canada, Mexico, and the United States are gathered from the Historical Climatology Network (HCN), and data from these stations were bootstrapped in order to expand the time series. Bootstrapping is the stochastic simulation of monthly data by the utilization of daily data with identical ENSO, PDO, and PVO (NAO) characteristics. Because the polar vortex occurs only during the cold season, the PVO was used during January, and the NAO was used during other months. Bootstrapped data were arranged and the tenth and ninetieth percentiles were analyzed. Magnitudes of temperature and precipitation anomalies were the greatest in the western Canada and the southeastern United States during winter, and these anomalies were located near the Pacific North American (PNA) nodes. Summertime anomalies, on the other hand, were weak because temperature variance is low.

Changes in wind direction in association with the phases of the El Niño-Southern Oscillation (ENSO) were identified over the southeast USA during the winter season (December-February). Wind roses, which depict the percentage of time the wind comes from each direction and can graphically identify the prevailing wind, were computed according to a 12-point compass for 24 stations in the region. Unfolding the wind rose into a 12-bin histogram visually demonstrates the peak frequencies in wind direction during each of the three (warm, cold, and neutral) phases of ENSO. Normalized values represent the number of occurrences (counts) per month per ENSO phase, and comparison using percent changes illustrates the differences between phases.

Based on similarities in wind direction characteristics, regional topography, and results from a formal statistical test, stations were grouped into five geographic regions with a representative station used to describe conditions in that region. Locations in South Florida showed significant differences in the frequencies in wind direction from easterly directions during the cold phase and northerly directions during the warm phase. North Florida stations displayed cold phase southerly directions and westerly and northerly directions during the warm phase, both of which are significant for much of the winter. Coastal Atlantic stations revealed winds from westerly directions for both phases. The Piedmont region had great variability in wind direction because of the influence of the Appalachian Mountains, but generally warm phase and cold phase winds had more zonal influences rather than winds from south or north.

Refinement and development of climate forecast products and their presentation to the end users

AgClimate was developed in response to the need for information and tools on proactive adaptations to seasonal climate variability forecasts in the southeastern US. Extension agents, agricultural producers, forest managers, crop consultants, and policy makers may use this decision support system to aid in decision making concerning management adjustments in light of climate forecasts. Adaptations include those that might mitigate potential losses as well as maximize yields. *AgClimate* is a web-based climate forecast and information system that was designed and implemented in partnership with the Cooperative State Extension Service. It has two main components: the front end interface and a set of dynamic tools. The main navigation menu includes the *AgClimate* tools, climate forecasts, and management options for crops, forestry, pasture, and livestock. It also includes a climate and El Niño section with background information. The tools section contains two applications that allow a user to examine the climate forecast for his/her county based on the ENSO phase and to evaluate yield potentials for certain crops. *AgClimate* is now operational under the Southeast Climate Consortium and several upgrades are under development and consideration (AgClimate.org). FSU will also continue development of new tools and climate variables for inclusion in *AgClimate*.

FSU has led the development of new tools and climate variables for inclusion in *AgClimate*. Tools displaying ENSO climate variations in such quantities as chill accumulation, growing-degree days, absolute minimum and maximum temperatures have been added to the basic climate variables available through *AgClimate*.

A systematic study of chilling for blueberry, peach, and strawberry in Al, FL, and GA was made and the significant impacts of ENSO on chill was characterized for counties and on a regional basis. Ongoing investigation seeks to identify the effects of ENSO signal dynamics on winter chill accumulations. With the support of cooperative extension and producers the research findings were embedded into two perennial fruit management tools that are currently being incorporated into *AgClimate*.

The chill accumulation tool allows producers select their crop and location to examine forecasts for chilling for bi-weekly and seasonal periods. The forecasts are presented in a probabilistic format and are modulated on the current JMA ENSO phase. This permits users to examine not only the total amount of chilling that will be accumulated in a year, but also the distribution of chilling through the dormant season. User are also able to examine how the forecast differs from expected conditions in their county and historical data over the preceding five years to help relate seasonal patterns to historical crop performance at their location.

The second application responds to producer requests for forecasts that summarize the available information and present it in a simplified and integrated fashion. Regional maps are provided to users that indicate the probability of chill accumulation for winter fruit crops to exceed the expected values for their location. Users are able to specify the bi-weekly forecast period throughout the winter that they wish to observe and ENSO based forecasts specific to their chosen crop are displayed.

Wildfire Risk Forecast System

COAPS continues to produce a monthly wildfire risk forecast operationally for the traditional wildfire season of January through July of each year. The wildfire activity potential forecast is based on the Keetch-Byram Drought Index (KBDI). Because of the chaotic nature of weather, all climate forecasts (including this wildfire threat forecast) are presented in terms of probabilities. Weather data that drives the forecast is taken from hundreds of NWS cooperative observer sites in Florida, Georgia, and Alabama.

Because the KBDI is driven by daily weather and can change drastically based on one or more rainfall events, the maps show the probability of exceeding the threat level *at least 7 days during the month,* rather than for the month as a whole. It has been shown that increased wildfire activity is linked with the deviation of the KBDI from seasonal normals (Goodrick, 1999). The KBDI tends to be at its peak in May in Florida, so values around 400 or 500 are not unusual at this time. Counties are given a plus sign to indicate a greater than normal threat for that month, and given a minus sign to indicate a risk level lower than climatology. The forecast is based on both initial conditions (current KBDI values) and expected climate patterns associated with ocean temperatures in the tropical Pacific. For this reason, the forecast is updated monthly throughout the season as conditions change in the field. The initial forecast is made in January for the months of January through July, and then updated monthly as the season progresses. The wildfire threat forecast is available via *AgClimate*.

The KBDI forecast format was developed through many discussions with fire weather experts at the Florida Division of Forestry, the Georgia Forestry Commission, USDA Forest Service, and with extension forestry specialists. The final product resulted after several versions and subsequent refinements from user feedback. The KBDI forecast was presented at the Eastern/Southeastern States Seasonal Assessment Workshop, sponsored by the National Interagency Coordination Center in January of 2006. The forecast is used by State forestry officials in their allocation of equipment and manpower and in decisions regarding the requests for additional resources. The forecast methods and verification have been published by Brolley et al. (2007).

The SECC evaluation team completed an assessment of the wildfire threat forecast system in 2007. State forestry officials, private forest managers, extension specialists, and other forestry interest were introduced or reacquainted with the KBDI forecast products, then interviewed on their presentation and utility. Results from this assessment will be submitted for publication in 2008, and the recommendation will be used to further refine the forecast products and methods.

As an aid to forecast verification and for other research and data needs, COAPS produced a data set of historical KBDI for over 50 years for all CO-OP in the states of Florida, Georgia, and Alabama (1948-present). Because the KBDI must be calculated with a continuous weather record, much work was done to fill data gaps using observations from surrounding stations. The reconstructed KBDI record was then used to search for seasonal and regional correlations between the drought index value and historic wildfire occurrences. The reconstructed KBDI was also shared with the State Forestry Commissions and other interested parties.

Outreach

The SECC sees outreach and education as a critical component of our activities. A key to the effective use of the information in *AgClimate* is the proper education and outreach to the users. The agriculture extension services in Florida, Georgia, and Alabama is a key partner in this outreach. FSU has participated in many extension-sponsored workshops in the last year and will continue to provide training and to promote *AgClimate* in the coming year.

University of Florida

In 2007, the principle focus of our work plan was to expand and improve *AgClimate*, though we also emphasized exploratory research on linkage of regional numerical climate models with agricultural models for increasing reliability of forecasts of climate and agricultural responses. We continued to explore the potential use of climate forecasts in reducing agricultural nutrient runoff and leaching into freshwater resources in Florida and Georgia watersheds.

The goal of the SECC is to develop a climate information and decision support system for the Southeastern USA that will contribute to an improved quality of life, increased profitability, decreased economic risks, and more ecologically sustainable management of agriculture, forestry, and water resources.

Objectives

University of Florida investigators focused on Objectives 2, 3, and 4 of the overall SECC objectives, namely:

2. Enhance and extend agricultural applications of climate forecasts in Florida and across Georgia and other SE states.
3. Develop and refine methods to incorporate climate forecasts in water resource management in Florida, Georgia and surrounding states.
4. Develop new and improved methods for integrating models from different disciplines for application of climate forecast information in agricultural and water resource decision making

University of Florida investigators also led the coordination and contributed to the other objectives. During 2007, we will focus our efforts on enhancing and evaluating the agricultural climate risk information system and on research to integrate climate information for agricultural and water resources management.

Coordination across locations

A significant part of the work at the University of Florida involves coordination across institutions and states in the SECC because the SECC Coordinator (Dr. Keith Ingram) is located at UF. In addition, UF has provided leadership in integrating SECC programs with Extension under the leadership of Dr. Clyde Fraisse.

Activity C.1. Communication and Liaison

The Coordinator organized regular meetings of the SECC Executive Committee, generally through tele-video conference. With representatives from UGA, the Coordinator organized an annual program review of SECC scientists held in Griffin, GA in May 2007. In addition, the Coordinator arranged an SECC delegation to visit the NOAA Climate Test Bed group in Camp Springs, in conjunction with the program an SECC scientist conducting collaborative research with the Climate Test Bed group. The Coordinator served as liaison to funding agencies, other RISAs, and related organizations to assure timely flow of information and represented the SECC at workshops, conferences, and other meetings.

__Activity C.2. Partnerships__

The Coordinator will assist SECC members in the establishment of new partnerships with the NOAA Climate Test Bed (CTB) group, including facilitation of a visiting scientist who made two 2-week visits to CTB, support of new collaborations with CLIMAS (with RISA funding) and NCSU (with USDA RMA funding) to support the transfer of *AgClimate* to these locations. In addition, we initiated partnerships with several governmental and private organizations that are interested in commercial applications of climate information, namely, the Florida Farm Bureau Federation, Florida Forestry Association, International Carbon Bank and Exchange, and CH2MHill. Our emphasis for 2008 will be development of new partnerships with organizations that provide outreach services to socially disadvantaged growers, for example, the North South Institute and the Federation of Southern Cooperatives.

__Activity C.3. Managing Complementary Activities with Different Funding Sources__

With 6 universities and 5 program areas, the Coordinator and other members of the Executive Committee have led the development of the SECC Strategic Plan, which guides collaboration and programs activities. In 2007, we began research on a new topic, climate change, which we will be incorporating into our Strategic Plan during full SECC meetings and meetings of individual research program areas during 2008.

__Activity C.4. Coordination of Extension activities__

In 2007, the University of Florida created a tenure-track Climate Extension Specialist position in the Institute of Food and Agricultural Sciences that will be converted to state funding after 2010, which has been filled by Clyde Fraisse, who has led the SECC extension effort since 2003. The SECC Extension Team now includes: two climate extension specialists, extension specialists in economics and hydrology, and one state climatologist, with evaluation and assessment support from two anthropologists and one natural resources economist, and overall support from the SECC Coordinator.

__Activity C.5. Climate Information for Managing Risk__

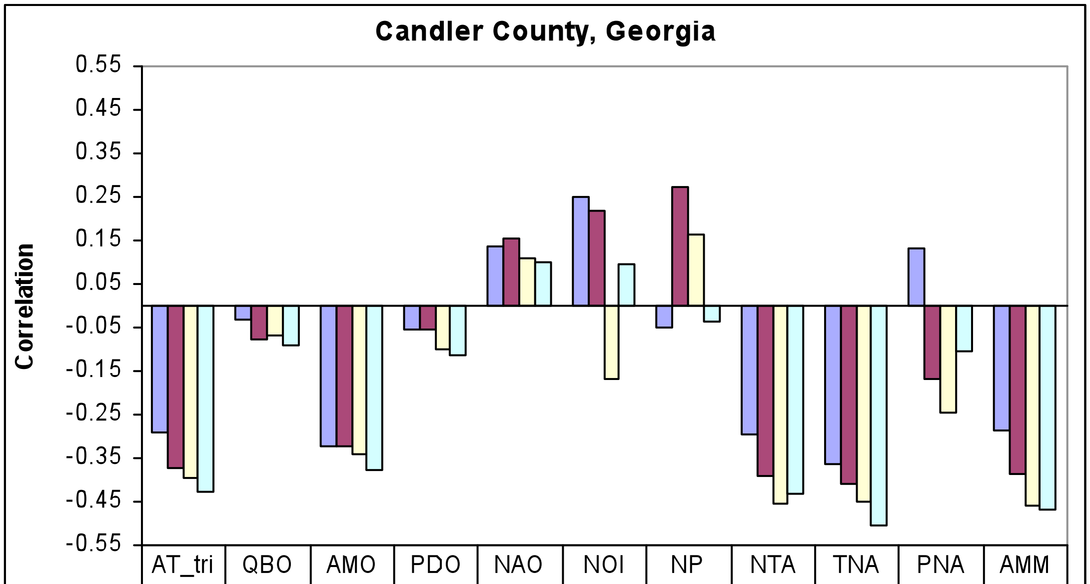
The SECC and UF are co-hosting a symposium entitled Climate Information for Managing Risks – Partnerships and Solutions for Agriculture and Natural Resources Managers. The symposium is scheduled for 11-13 June 2008. Prof. Jim Jones chairs the organizing committee and Keith Ingram is co-chair.

Objective 2: Enhance and extend agricultural applications of climate forecasts in Florida, Georgia, Alabama, and other states

__Activity 2.1. Expand climate risk analysis products for different crops__

Activity 2.1.a. Assess the potential of using principal components to forecast cotton yields at field and county scales

Monthly climatic indices published on the NOAA website were correlated with observed cotton yield for all cotton producing counties in the southeastern USA. As a result of this analysis, list of pre-season (Jan-April) climatic indices were obtained that were significantly correlated with cotton yield for each county. Currently, monthly rainfall and temperature data is being gathered for each county to investigate their correlation with climatic indices. Those analyses will be used to explain the significance of correlation of climatic indices with cotton yield. An example of correlation plot for one county is shown in the figure below.



	AT_tri	QBO	AMO	PDO	NAO	NOI	NP	NTA	TNA	PNA	AMM
January	-0.29	-0.03	-0.32	-0.06	0.14	0.25	-0.05	-0.30	-0.36	0.13	-0.29
February	-0.37	-0.08	-0.32	-0.06	0.15	0.22	0.27	-0.39	-0.41	-0.17	-0.39
March	-0.40	-0.07	-0.34	-0.10	0.11	-0.17	0.17	-0.45	-0.45	-0.24	-0.46
April	-0.43	-0.09	-0.38	-0.12	0.10	0.10	-0.04	-0.43	-0.50	-0.11	-0.47

Fig. Correlation of cotton yields in Candler County, GA with monthly (Jan-Apr) climatic indices.

Based on the correlation analysis results for climatic indices with the cotton yield, supervised principal component analysis was performed on significant climatic indices. Multiple linear regression models were developed for all the counties using only significant principal components. Models were evaluated using cross validation approach, leaving one observation out at a time. Skill level testing was done on predictions to evaluate the results. Earliest prediction of cotton yield was obtained in the month of April. As an extension, predicted monthly climatic indices will be used to obtain the forecast to find out how early we can make predictions and weather that will be useful to the farmers.

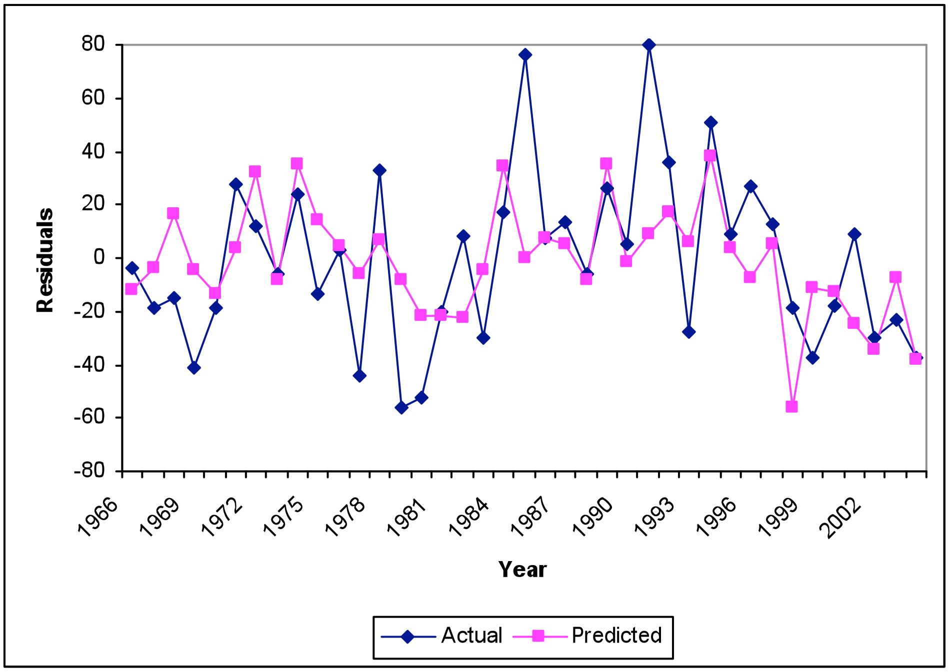


Fig. Time-series plots of actual and predicted cotton yields for Candler County, GA.

Activity 2.1.b. Document the historical yield tool for Extension applications

Online help ha been developed for the Agclimate decision support tools including the historical yield tool and are now available on *AgClimate.org.* In addition, an extension publication has been published explaining the use of crop yield risk tools available on AgClimate: Fraisse, C.W., J. O. Paz, and C. M. Brown. 2007. Using seasonal climate variability forecasts: Crop yield risk. University of Florida IFAS Extension, Circular EDIS AE404.

Activity 2.1.c. Evaluate the FSU weather generator for different locations across the SE USA for use in a spatial weather generator

Weather generators are particularly useful when relatively few years of weather observations are available. For the SECC, this is most notably the case when we deal with ENSO phase data, where we commonly have 8 to 16 years of observations. Our work in this activity focused on two related questions:

1) Does the generator reasonably capture inter-annual weather variability due to different ENSO phases?
2) How many years of weather data are needed to characterize a site's longer-term weather?

To answer the first question, we utilized two SECC developments: the Schoof weather generator and the Zierden modification to the JMA ENSO index. The weather generator was parameterized with DSSAT-ready observed weather data, i.e., observations previously processed to include daily solar radiation data and to eliminate missing values. The data were sorted by ENSO phase, according to the Zierden-modified JMA ENSO index. For each of 11 sites in Alabama, Florida and Georgia, we produced 100 years of daily data (solar radiation, maximum temperature, minimum temperature, and rainfall) based on each ENSO phase (El Niño, La Niña, or Neutral), plus 100 years based on the complete series (climatology).

Statistical comparisons showed that, while the generated weather reproduced mean monthly rainfall by ENSO phase, the average number of days per year with freezing temperatures was consistently underestimated, particularly during the ENSO neutral condition. This may be particularly important in south Florida, since crops grown there can be very cold sensitive.

The second question is currently being approached by comparing data generated using varying subsets of the observed data, to the entire set of observed data. We began with a series from Hillsborough Co., Florida, which has 107 years of daily, using 10-year subsets for parameterizing the generator. The accompanying table shows mean monthly rainfall derived from a) the full 107 observed years; b) 100 generated years parameterized with the full series of 107 observed years; c) the most recent 10 years; d) 100 generated years parameterized with the most recent 10 years; e) a random selection of 10 years; and f) 100 generated years parameterized with the randomly selected 10 years.

Monthly Means of Observed and Generated Rainfall (mm)

	All Observed Years	Generated from All Years	Most Recent Observed	Gen from Most Recent Obs	Random Observed	Gen from Random Observed
Jan	**63**	58	62	58	76	76
Feb	**75**	63	68	58	45	43
Mar	**90**	82	74	71	77	74
Apr	**62**	48	62	74	69	64
May	**97**	91	70	68	152	146
Jun	**206**	196	233	241	213	215
Jul	**210**	217	208	204	249	242
Aug	**222**	221	235	229	263	233
Sep	**172**	163	217	213	156	166
Oct	**71**	75	59	62	61	61
Nov	**47**	43	49	51	27	27
Dec	**60**	60	96	84	96	92

***Activity 2.2. AgClimate* enhancement and transition**

The main accomplishment related to *AgClimate* during 2007 was the transition to IFAS Extension. Main objectives under this activity included:

- To establish the personnel and infrastructure needed for the transition of *AgClimate* from Research to Extension;
- To create a mirror *AgClimate* site that will be maintained by Florida Extension Services;
- The transition of climate, crop yield, and forestry tools to the Extension *AgClimate* site.

All objectives were accomplished, *AgClimate* is currently operating in new servers maintained by the University of Florida computer network systems that are also shared by the Florida Agricultural Weather Network (FAWN) system. Two servers are operational and a third server, located at the Agricultural & Biological Engineering Department (elnino.agen.ufl.edu) is used as a staging site for the climate and weather systems.

Activity 2.3. Support to InterRISA Project with CLIMAS

Several activities were undertaken during 2007 to support the transfer of *AgClimate* to New Mexico. An initial assessment of stakeholders needs in terms of climate information was done in Albuquerque, NM on December 03, 2007 at a meeting to introduce New Mexico State University (NMSU) Extension agents to *AgClimate* and its decision support tools. The main goal was to have Extension agents evaluating the system and identifying needs and adaptations that would be required for serving their clients in the region.

Programmers from the University of Florida have also provided support to programmers at NMSU in the design and implementation of the climate database requirements to support a stand alone version of *AgClimate* that will be implemented at NMSU. Initial climate data gathering and organization is currently taking place and we expect to have a test version of the system ready for evaluation by stakeholders by mid-April 2008.

Objective 3: Develop and refine methods to incorporate climate forecasts in water resource management in Florida, Georgia, and surrounding states

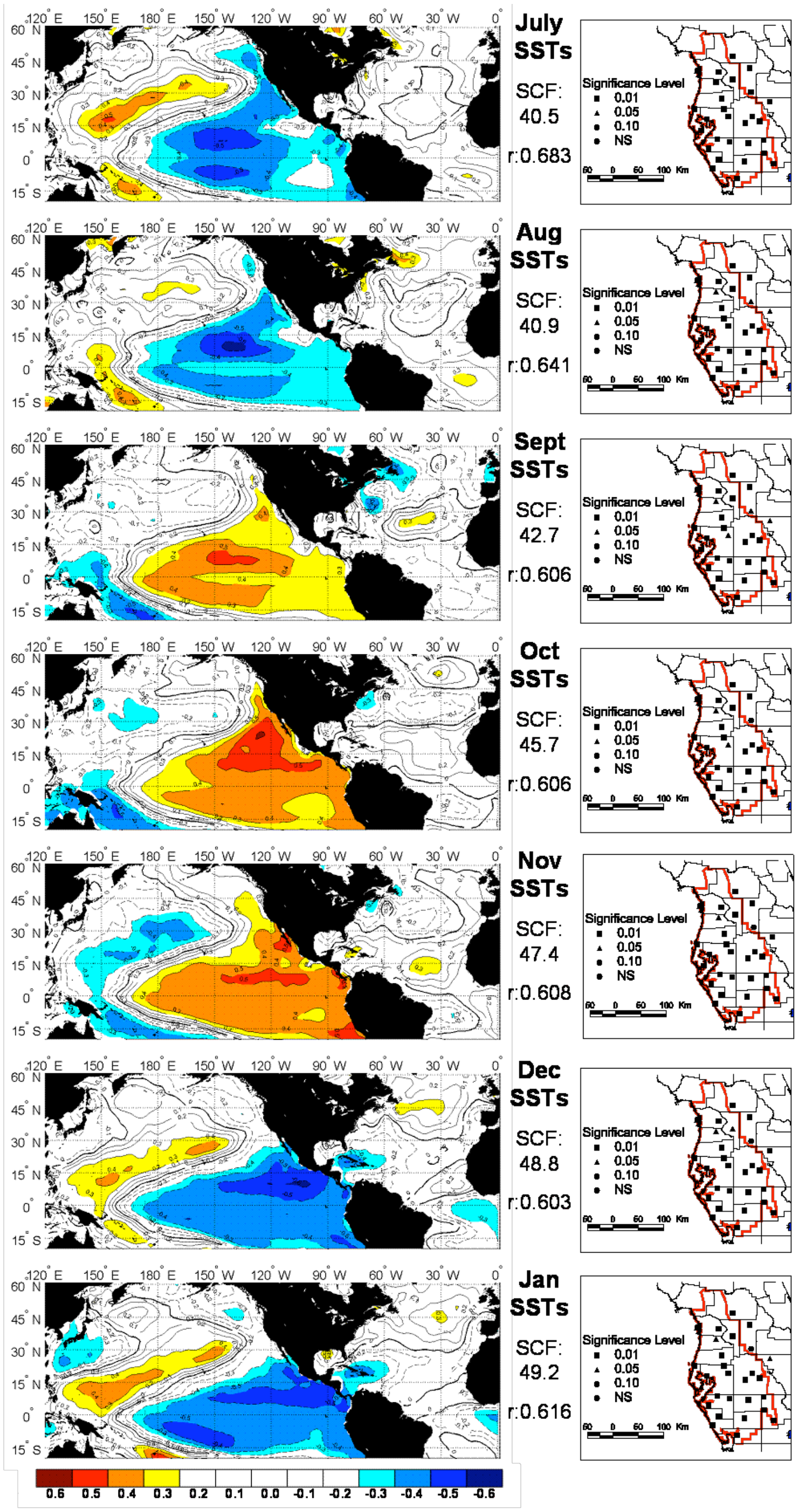
Activity 3.1. Integrate agricultural and hydrological models

Working with UF staff, Soil & Water Engineering Technology, Inc., (SWET) staff developed a linkage between Watershed Assessment Model (WAM) and Decision Support System for Agrotechnology Tranfer (DSSAT) models. This linkage provides a model capable of simulating the effects of climate scenarios on water quantity, water quality, and plant growth and yields. SWET staff also provided a 2-day WAM training course that was well attended by members of the SECC project. Technical assistance for the WAM was provided to several project sub-teams. A refereed paper was written by team members based on the water quality impacts of climate scenarios using WAM.

Activity 3.2. Use of seasonal climate forecasts to reduce risk in regional water supply management

Water supply managers in Florida are increasingly turning to alternative sources in order to minimize the environmental impact of groundwater withdrawals. As part of a study to improve source allocation decision making in Southwest Florida, an evaluation of Pacific and Atlantic Ocean sea surface temperatures (SSTs) and monthly rainfall (1970-2006) was performed to identify coupled modes of variability. The monthly patterns of rainfall were analyzed in relation to SSTs using singular value decomposition analysis (SVD). Time-lagged analysis of SSTs and rainfall were investigated in order to identify SST regions that show forecast potential.

Field-significant correlations were found only for the leading SVD mode. The leading SST expansion coefficients corresponded strongly with the eastern tropical Pacific ENSO signal. Significant coupling was found between SSTs and monthly rainfall between November and April. Coupling of November, January, February, and March monthly rainfall with SSTs were found to be significant at 0-6 month lead times. Coupling of December rain was significant at 0-2 month lead times, and the coupling of April rainfall was significant at 0-4 month leads.



Pearson's correlation between July – January SSTs and rainfall in the Southwest Florida Water Management District. Changes in sign of the SST correlation is accompanied by a change in sign of rainfall station correlation and is an artifact of the SVD method. Also shown is the

Pearson's correlation (r) and squared covariance fraction (SCF) of the leading SVD modes of the two fields.

Objective 4: Develop new and improved methods for integrating models from different disciplines for application of climate forecast information in agricultural and water resource decision making

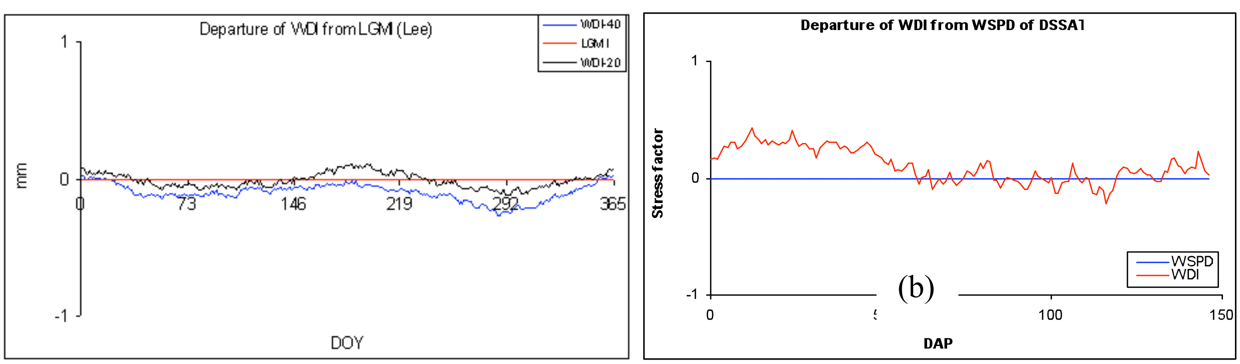
Activity 4.1. Developing a Water Deficit Index (WDI) for quantifying crop water stress

The purpose of this study was to develop an agricultural water deficit index that is both simple and based on sound physics and physiology. The proposed index, Water Deficit Index (WDI), is a function of actual to potential transpiration ratio:

$$WDI = 1 - T/T_p$$

Where: T = actual crop transpiration, mm
T_p = potential crop transpiration, mm

We estimate T_p using the FAO-56 model, T from water uptake coefficient and available soil water: $T = \alpha(\theta - \theta_{wp})$. Using historical weather data of four locations, daily WDI and LGMI values were computed for grass and DSSAT stress factors were computed for maize. These values then were used to calculate the departure of WDI from LGMI and DSSAT (Figure 1). Although LGMI and WDI showed similar trends of crop water stress, LGMI values were always greater because of LGMI uses unrealistically high estimates of evapotranspiration. Except during initial crop stage, WDI and DSSAT showed similar water deficit levels. The difference between indices during crop establishment was because WDI calculated the stress for a grass having a constant canopy, whereas DSSAT did so for maize having small canopy. Like LGMI, WDI is calculated from readily available weather data. Yet WDI is more realistic than LGMI because WDI has more realistic evapotranspiration and soil water balance functions.



(a)

Figure. Departure of WDI from LGMI (a) and DSSAT (b)

University of Georgia

Objective 1. Develop downscaled ENSO climate information and forecasts for Florida, Georgia, and other southeastern states

Development of numerical tools for the analysis of climatic time series.

Several numerical tools were developed to provide a common platform for the systematic, reproducible, and statistical analysis of hydroclimatic data. These tools consist of a series of libraries of functions (packages) written in Python, a powerful, open-source, platform-independent scripting language. These packages are based on Numpy/Scipy, a library for scientific and engineering computing considered the *de facto* standard for the manipulation of multidimensional arrays in Python. At the core of these tools is a reimplementation of the way series with missing data are handled in Numpy. Our modifications have been included in the latest official release of Numpy (1.0.5). A second series of modules has been developed for the manipulation of time-indexed datasets and is also readily available as a specific Scipy package (scikits.timeseries).

Comparison of ENSO indicators

The Japanese Meteorological Association (JMA) index is used by the SECC for characterizing ENSO episodes. In its standard application, El Niño (La Niña) is defined to be when the 5-month average sea surface temperature anomalies recorded in the tropical Pacific Ocean are +0.5^{o}C greater than (-0.5^{o}C lower than) the climatological average for at least six consecutive months, including October. The episode then lasts from October through the following September. We investigated a modification to this method, where the episode stops as soon as the temperature conditions are no longer met. We compared the two approaches by analyzing differences in mean and median average monthly precipitations recorded on 172 stations over Alabama, Florida and Georgia. The two methods gave equivalent results from September to March: El Niño (La Niña) episodes were associated with dryer (wetter) conditions over the three states. For these months, the modified method yielded slightly more significant results. However, with the modified method, significantly less (more) precipitations were recorded in Alabama and central Georgia during El Niño (La Niña) episodes. We applied the two methods to estimate the impact of ENSO variability on the low flows of seven streams in south Georgia. Four stations were located in heavily irrigated areas of southwestern Georgia, whereas the other three stations were located in areas of southeastern Georgia with virtually no agriculture. For the three southeastern stations, low flows recorded during La Niña (El Niño) episodes were usually lower (larger) than the low flows recorded during Neutral episodes from November to April, with differences significant at a level of at least 90% from February to April (January to March) only. The four southwestern stations responded similarly, but the significance of the differences was usually lower than for the southeastern stations. The modified JMA indexed tended to give more significant results than the original index.

We also compared the modified JMAI with the Oceanic Niño Index (ONI), defined by the US Climate Prediction Center, which is the main indicator used for their regular ENSO outlook. We compared the timing and strength of El Niño and La Niña episodes as defined by the two indicators. The analysis showed an apparent bias of -0.4^{o}C for the ONI before April 1952, resulting in an overestimation of the number and strength of La Niña episodes, and an underestimation of the El Niño episodes. After 1952, the two indicators gave similar results, with the ONI detecting 25% more episodes than the JMAI. We applied the two indicators on the precipitation datasets recorded over Alabama, Florida and Georgia. The JMAI appeared to be usually more sensitive than the ONI, with more stations reporting a significant impact of ENSO phases, at greater degrees of significance. Therefore, the use of the modified JMAI might be recommended to assess the influence of ENSO phases on environmental data.

Weather data

Daily weather data for Alabama (44 locations), Florida (58 locations), and GA (62 locations) obtained from the Cooperative Observer Program (COOP) network and compiled by the Center for Oceanic-Atmospheric Prediction Studies (COAPS), are ready until 2006. The historical weather data include observed daily maximum and minimum air temperature and rainfall and generated daily solar radiation.

Lead-time climate and weather data forecasting

Some of our activities focused on using pattern recognition for any possibility of lead time forecasting of realization of daily weather data consisting of precipitation, maximum and minimum temperature and solar radiation. An algorithm for daily weather data series prediction based on the k-NN approach was developed.

To test our algorithm of pattern recognition we used 10 different sites across the state of Georgia. This approach was verified across the world for 16 different sites, with at least one site from each continent.

Objective 2. Enhance and extend agricultural applications of climate forecasts in Florida, Georgia, and other southeastern states

Agricultural Outlooks

Climate and commodity outlooks were developed in close collaboration with different SECC members and University of Georgia (UGA) Research and Extension Faculty. These outlooks were disseminated in various media forms and outlets to stakeholders including county agents and growers. A significant outcome was the increased visibility of the climate extension program as a result of extension specialists and county agents developing their recommendations (e.g. peanut, cotton, turfgrass management) based on the impacts of climate forecasts.

Simulated yield

The CSM-CROPGRO-Peanut and CSM-CROPGRO-Cotton models were run for all counties producing both crops in the three states. The counties were selected on those who produced these crops during the period from 1975 to 2006 as reported by USDA-NASS.

Pests and Diseases

We examined the effects of El Niño-Southern Oscillation (ENSO) on the prevalence of tomato spotted wilt virus (TSWV) in peanut, and how a weather-based component can be integrated with the current TSWV risk index. The goal was to develop a tool to assist peanut growers in effectively managing spotted wilt disease. Analyses of the five-year TSWV survey dataset (1998, 1999, 2002, 2004 and 2005) showed a varying level of interactions between the ENSO phases and different components of spotted wilt risk index. The results indicate that the severity of spotted wilt in peanut was consistently lower in a La Niña compared to an El Niño or a Neutral year. TSWV severity during a Neutral phase was lower than in an El Niño year, but the differences were not significant. Deviation from the mean severity during different ENSO phases showed a similar trend, with lower than average severity during La Niña years. There were significant interactions between ENSO phases and the individual risk index component. The available data indicate that climate played a significant role in spotted wilt severity of peanut. Climate might indirectly affect spotted wilt severity through varying weather patterns and weather parameters, including temperature and cumulative rainfall. In addition to the risk index component, the average daily air temperature in April, the mean daily minimum air temperature in March and April, the number of rain/wet days in March, total rainfall for April, and the amount of water balance (rainfall minus evapotranspiration) for April, provided significant contributions in predicting the severity of spotted wilt in peanut. A nonlinear regression analysis of the interaction between TSWV risk index point (excluding herbicide and plant population) and wet or rainy days in March showed an additive effect of the two variables on spotted wilt severity.

Objective 3. Develop and refine methods to incorporate climate forecasts in water resource management in Florida, Georgia, and surrounding states

HydroClimate

A template for a new water management website was developed using input from water managers and other stakeholders. Development focused on content and links requested by the managers. Water managers and stakeholders emphasized the need for a website domain name that is simple and easy to remember. They liked the name of the *AgClimate* web site, but did not agree on a similar domain name for a water management site. The most liked suggested domain name was SoutheastWaterOutlook.org, but there was no firm agreement. Water managers requested that we offer a variety of links to other websites which would make their decision-making process more straightforward.

Water managers suggested several tools which could be developed to help them with their management decisions. Reservoir managers most often requested estimations of evaporation to help them with water balance calculations. While they were particularly looking for short-term term estimates to help them with operational activities, they are also interested in longer-term outlooks which could help in planning pool levels for future seasons. Another tool that was requested was the effect of ENSO on precipitation and temperature based on watersheds rather than counties or states, although they would also like the county information available.

Objective 6. Document and assess the utility and impact of climate forecast information provided to stakeholders in agriculture and water resource management

Training Workshops

We conducted three workshops on *AgClimate* decision support tools for county agents, as part of a program to increase awareness on the use of climate information and climate-based tools available to stakeholders. We also conducted an *AgClimate* workshop for growers in Alabama. We were involved in various agent trainings, county meetings and Extension Winter conferences, emphasizing the importance of climate forecasts in farm decisions and risk management.

In response to the effects of extreme drought that affected several counties in Georgia, we worked with UGA faculty members from the departments of Agricultural Economics, Animal Science Crop and Soil Sciences to provide training and educational workshops on drought and livestock management to county extension agents, cattlemen, and ranchers across the state. Agricultural commodity outlooks were developed in close collaboration with different SECC members and University of Georgia (UGA) Research and Extension Faculty. These outlooks were disseminated in various media forms and outlets to stakeholders including county agents and growers. Updates on commodity outlooks will be released if there are any significant impacts of any changes in climate forecasts.

Identification of end-users, understanding decision processes, and the role of climate forecasts

Roncoli and Crane presented a display at the Georgia Organics' annual conference in Douglas, GA (March 8–9, 2007). More than 400 people attended. Organic production is the fastest growing agricultural sector in Georgia and involves highly educated and computer literate individuals, some of whom are new to farming. Therefore, they are well-positioned and highly motivated to use climate-based decision support tools, such as AgClimate. The SECC was also listed in the Georgia Organics Resource Directory, which is available free online, as well as printed in 20,000 hard copies and the SECC La Nina forecast was publicized in the Fall 2007 Georgia Organics Newsletter (The Dirt) which goes out to 800 members.

Carla Roncoli participated in events centered on African American and minority rural communities, such as the Conference of Black Environmental Thought at Tuskegee University (May 23, 2007) and the 40th Anniversary of Federation of Southern Cooperatives (FSC) in Birmingham, AL (August 16, 2007). These events yielded contacts for future outreach activities (e.g. inclusion of a SECC display during the FSC Annual Meeting in Albany, GA on February 8-9, 2008). Because African American farmers do not often have irrigation on their farms, they are particularly vulnerable to climate variability. But, since they mostly engage in part-time, small-scale operations, they are rarely reached by conventional extension.

Evaluating AgClimate tools in terms of their potential and actual uses and impact

To better understand what kind of information producers need and how to communicate it them, Roncoli and Crane conducted semi-structured interviews with South Georgia farmers from January to March 2007, including 38 farmers in 20 counties, which represented a broad cross-section of production systems found in Georgia. The objective of these interviews was to examine farmers' decision-making processes, to identify how climate variability factors into them, and to identify which decisions were or may be influenced by forecasts. The research also elicited farmers' views on what climate parameters are most useful and what communication modes are most effective to reach them.

The study found that most farmers are keen on receiving more climate information. Farmers most commonly seek short-term weather forecasts but they are also interested in the overall season trends. Among other potential adaptive responses to climate forecasts, farmers mentioned: a) adjusting expenditures, insurance coverage, and chemical input application; b) modifying the timing of planting and harvesting; c) planting more or less in certain fields/soils; d) selecting crops and crop varieties; e) preparing irrigation equipment; f) implementing soil and water conservation. Our research also documented how some farmers have used the SECC's information system. In spring of 2006, the SECC forecasted a drier than normal summer. The extension agent in Irwin County received the SECC forecast and included it in a column he normally writes for the local newspaper. He reported that this led many farmers to switch to peanut varieties that mature in 90 days, instead of the normal 120-day varieties.

The research also elicited farmers' views on what parameters are most useful and what communication modes are most effective to reach them. Farmers suggested that decision support tools should be clear and user-friendly, regularly updated, locally specific and that the track record for the forecast be published, so that they could evaluate to what extent it can be relied upon in decision-making. They expressed an interest in knowing more about how and by whom the information is produced, and expressed confidence in information that comes from land-grant universities.

Assessing the accessibility, relevance, utility of AgClimate tools from end-users' point of view

An assessment of *AgClimate*, based on multiple activities with a diversity of users, was conducted from fall 2006 though spring 2007 under Roncoli's direction. The assessment included seven hands-on classroom evaluations, twelve IT expert evaluations and evaluations by extension agents at three *AgClimate* training workshops. Quantitative data from evaluations were complemented by qualitative feedback gathered in the evaluations as well as during outreach events and from agents and farmers during interviews. Quantitative data gathered in the student and agent evaluations on site content, design, navigability, support, user interface, and overall satisfaction. Both students and agents consistently gave positive ratings in all themes.

Qualitative feedback indicated that users most like the comprehensive collection of information in one place, the availability of historical yield data, the various crop tools (especially chill units, freeze risk maps and growing degree days), and the ability to make comparisons illustrating the effects of ENSO phase on all of these functions. Suggestions included to cultivate a recognizable identity for *AgClimate* and habitual reference (by keeping information update), to highlight the link with land-grant university and the background of SECC scientists, to provide contact information and interactive questioning function, and to enable users' own assessment by clarifying issues of probability and by publishing the forecast performance track record. During 2007 Roncoli and Crane have worked closely with the *AgClimate* team to implement the user feedback.

University of Miami

Breuer led, collaborated, or participated in many SECC activities not related directly to publication, research, but important for the daily functioning of the consortium. These present challenges to supervisors because of their qualitative nature. Nevertheless, they occupy, as always, a considerable amount of my time. Examples of these follow.

- Facilitated AgClimate workshops in Homestead, Griffin, Tifton, and co-developed agenda, exercises, and evaluation materials for these with Clyde Fraisse, Carla Roncoli, and Joel Paz.

- Traveled to interview agricultural producers, research stations, Florida cooperative extension offices, and other potential stakeholders for SECC research projects. These were all in Florida either alone or accompanied by Clyde Fraisse or other UF faculty.

- AgClimate: cooperated on a weekly basis with the AgClimate technical team resolving information needs, advising, programmers on agronomic data, and presentation of graphic user interphase. Participated regularly, through a group of advisers throughout Florida, in preparing quarterly agricultural outlooks. Coordinated right-up of climate change fact sheet among SECC members with disparate views and opinions.

- Facilitated phone conference calls among the SECC assessment team. Others present were typically Carla Roncoli, Todd Crane, and Kenny Broad.

- Developed a presentation and facilitated a 40-min. discussion on "Co-development of climate tools and future directions or research," on April 13, 2007. Among those present were Jim Jones, Clyde Fraisse, Dr. Ken Boote, Fred Royce, John Lisazo, Guillermo Baigorria, and some ten graduate students from the McNair Bostick Crop Modeling Lab.

- Regularly attended and participated in Polycom conferences of the SECC extension team. Others present were typically Joel Paz, Carla Roncoli, Todd Crane, Clyde Fraisse, Keith Ingram, and James Novak.

- Attended and acted as sub-coordinator of SECC water resources working group meeting held in Tallahassee. Presented talk on how to incorporate stakeholder assessment into water resources research.

- Developed a potential inter-RISA collaborative research project with Niina Haas and Mike Crimmins, of Arizona CLIMAS.

- Co-wrote assessment section for RMA and NOAA reports

- Interviewed on climate variability, change and mitigation strategies on Radio Bilingue. This is a bi-lingual radio station with national coverage. The interview was in Spanish.

Publications

Refereed journal articles and book chapters

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